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CALIFORNIA ENERGY FLOW IN 1981

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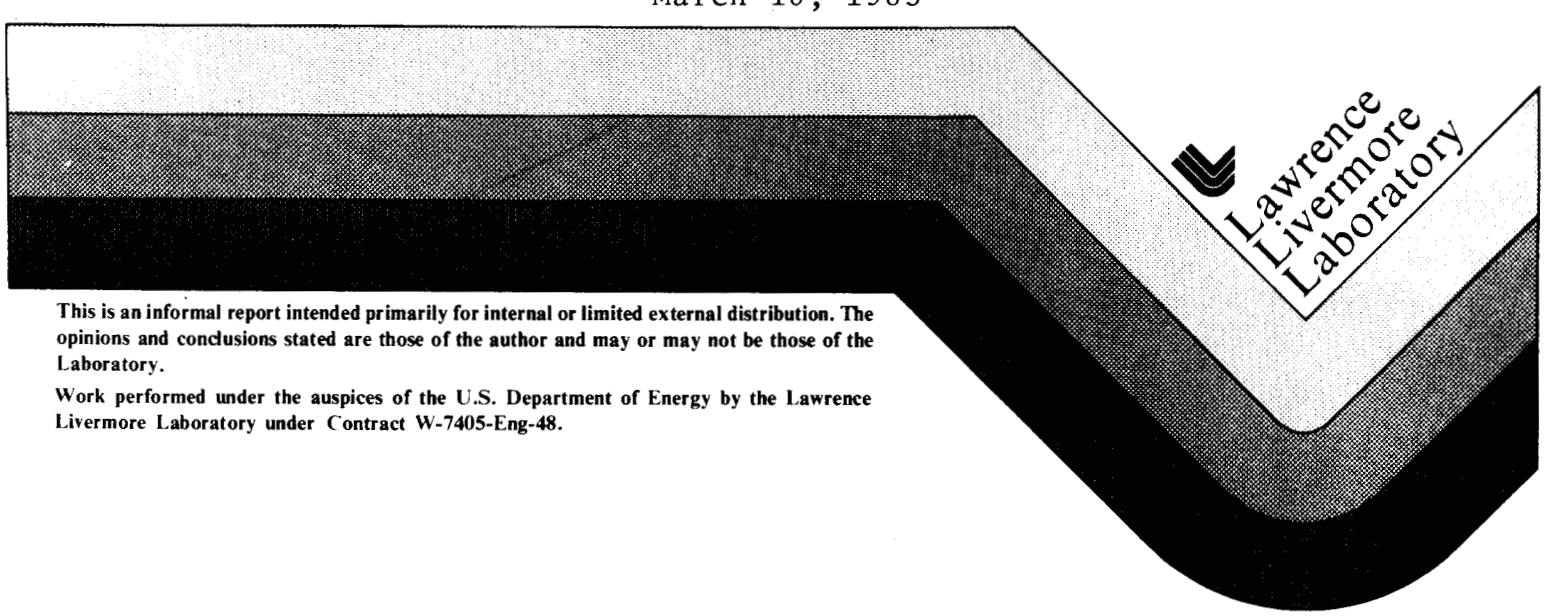
March 10, 1983



ABSTRACT

The overall energy picture in California in 1981 was strongly influenced by the nationwide recession and a mild winter. The total consumption was 6.3 quads, down from 6.4 quads in 1980. The largest changes from the previous year are in the decline in imports of foreign crude oil and large increase in use of natural gas for electric power production, which is part of a trend starting in the late seventies. California crude oil production hit an all time peak, but it was not paralleled by an historic high in natural gas production. Coal continues to have virtually no role in the California energy fuel mix, and all plans for its use were abandoned in 1981. The utilities are instead turning to purchases of electric power from small producers (solid waste and cogeneration, wind power, small scale hydro, etc.). They comprise about 1% of the total generating capacity in the state in 1981. Large purchases from out-of-state sources were negotiated as well. The utilities plan to put on line or enlarge other base load generating facilities such as Diablo Canyon Nuclear Plant, the Geysers and the Helms Pumped Storage Plant in the next few years. Nuclear energy's contribution to the state's power declined due to equipment failures and refueling. Diablo Canyon's license was revoked in late 1981 due to faulty seismic supports.

Conservation driven largely by price increases in fuels was apparent in some end use sectors. However, its effect and that of improved mileage of the state's automobiles were obscured by the population increase and uncertainties in the data themselves.

The historic disparity between the California and overall U.S. energy supply and use persists into 1981.

INTRODUCTION

For the past seven years, energy flow diagrams for the State of California have been prepared from available data.[1-6] They have proven to be useful tools in graphically expressing energy supply and use in the State as well as illustrating the large differences in energy use between California and the nation as a whole.

As far as possible similar data sources have been used to prepare the diagrams from year to year, and identical assumptions[2] concerning conversion efficiencies have been made in order to minimize inconsistencies in the data and analysis. In 1981, a major source of data for earlier energy flow charts was discontinued - the Quarterly Fuel and Energy Summary, California Energy Commission (QF&E). Much of the information formerly collected in QF&E is no longer published. Thus, alternate data sources, such as Department of Energy and the American Gas Association have been used in the present 1981 analysis. Judging from differences in the data reported in 1980 by the California Energy Commission (CEC) and other data collecting agencies, comparisons of 1981 supply and usage based on new sources with previous years analyses based chiefly on CEC data must be done with reservations. In the case of end use, different aggregation into industrial/commercial/residential categories in 1981 from 1980 and previous years bars meaningful comparisons. Nonetheless, taken overall some generalizations can be made concerning changes in the overall energy picture in California. Presumably in subsequent years, closer quantitative analysis and comparison from year to year will again be possible.

DATA SOURCES

Appendices A and B summarize the primary sources used in preparation of this report. New publications of the CEC were used in some instances. For example, data reported in QF&E pertaining to electric generation and natural gas sales, production and deliveries are now reported in the Quarterly Supplement to CEC's monthly Energy Watch under the mandate of Public Resources Code Section 25322.

Oil data formerly collected in the CEC Quarterly Fuel and Energy Reports now appear in the CEC Quarterly Oil Report. On October 1, 1981, the CEC completed implementation of the Petroleum Industry Information Reporting Act of 1980 (PIIRA). The PIIRA data collection system is CEC's principal method for collecting data on crude oil and refined petroleum products. Quarterly Oil Report for the 4th Q 1981 is the first to present analyses based on the new reporting system. The Petroleum Supply Annual 1981 and the new Electric Power Annual for 1981 both published by the DOE/EIA were also important sources of data for the first time. Many of the tables in these national publications are broken down by state. Other valuable sources are the new CEC publication Annual Petroleum Review 1981, the 67th Annual Report of the State Oil & Gas Supervisor, and the 1982 California Gas Report covering historical period 1977 through 1981 and published under the auspices of the California Public Utilities Commission by a committee comprised by major utility representatives.

Data on electrical power imports were obtained from information provided by CEC staff. Out-of-state hydro-electric power is from the Pacific Northwest (Bonneville Power Administration) and the Southwest (principally Hoover and Davis Dams on the Colorado River). The transmitted electrical power from imported hydro sources was derived from the net exchange in interstate transfers; power from out-of-state coal-fired plants is recorded separately by the CEC. Out-of-state coal fired plants are at Four Corners, Farmington, New Mexico; the Navaho Plant at Page, Arizona; and the Mohave Plant, Nevada.

1980 ENERGY FLOW COMPARED TO PREVIOUS YEARS

Figure 1 is the flow diagram for 1981 and Figure 2 is for the previous year. Data from other years are compiled in Table 1 for comparison.

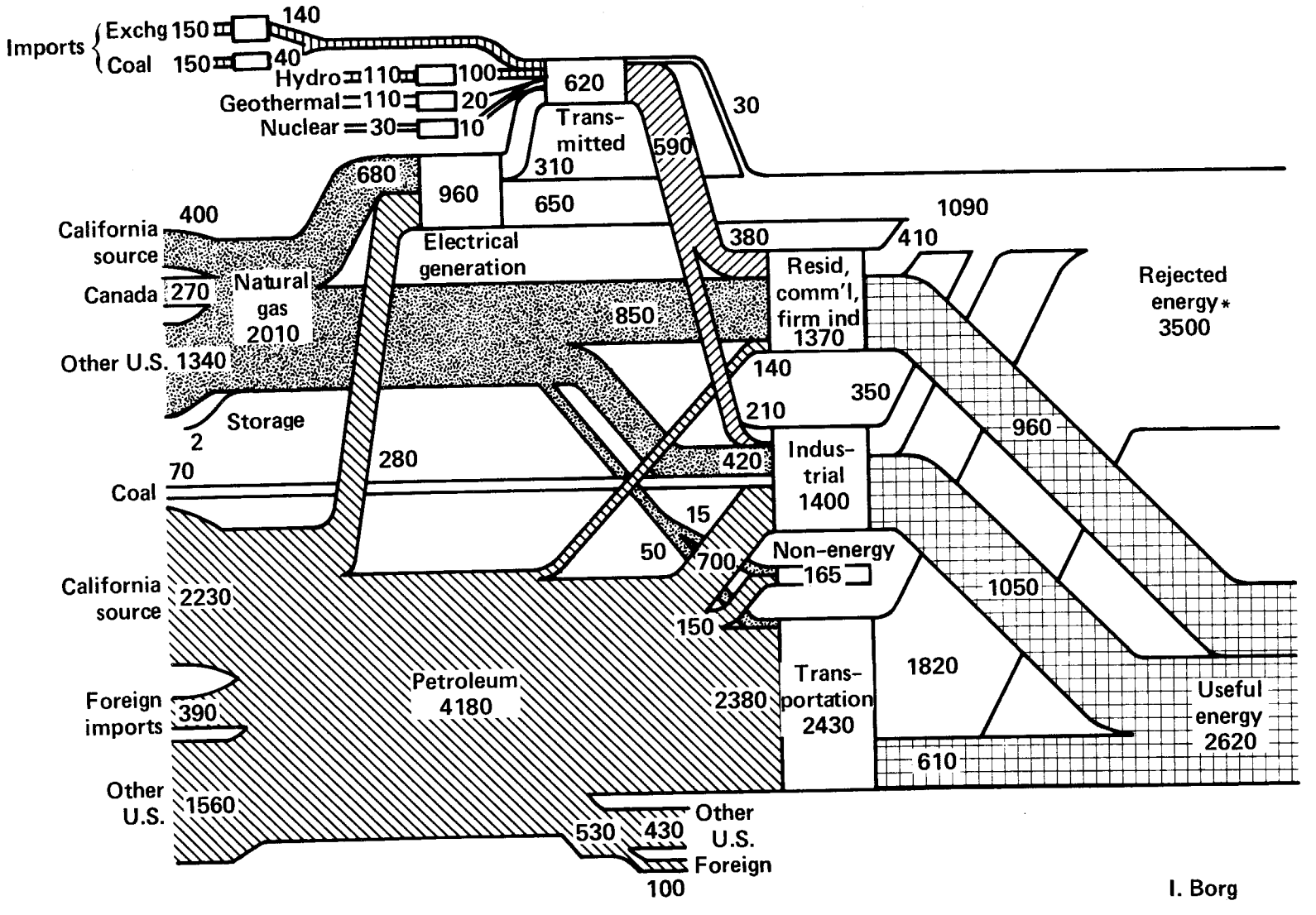
Noteworthy changes in the supply in 1981 include:

- Drop (34%) in imported foreign oil
- Increase in indigenous California oil production to an all-time record high
- Large increase in use of natural gas for power production for the second year
- Continued decline in share of electic power generated with nuclear fuels
- Substantial increase in use of geothermal and renewable energy resources for power production.

As previously described, due to use of new data sources comparison of energy consumption in the various end-use sectors is not valid in all instances. The problem centers on the distinction between industrial and commercial use. The use in the "non-energy" section dropped. This category includes petrochemicals, asphalt, waxes, fertilizer etc.; these uses produce neither heat nor mechanical work. The 1981 decline in non-energy use reflects on the contraction of the fertilizer industry in the state in part due to the increased cost of natural gas under the Natural Gas Policy Act of 1978.

The net decrease in the use of total energy in 1981 is related to the continuing recession. Unemployment in the state involved more than a million people or some 8.9% of the work force by December. The prime rate ranged between 17 and 20% during most of the year. The decrease in energy use had its clearest expression in the decline in the use of crude oil. Foreign imports fell substantially, and even purchase of out-of-state oil fell. Complete decontrol of domestic crude oil prices took place at the beginning of the year.

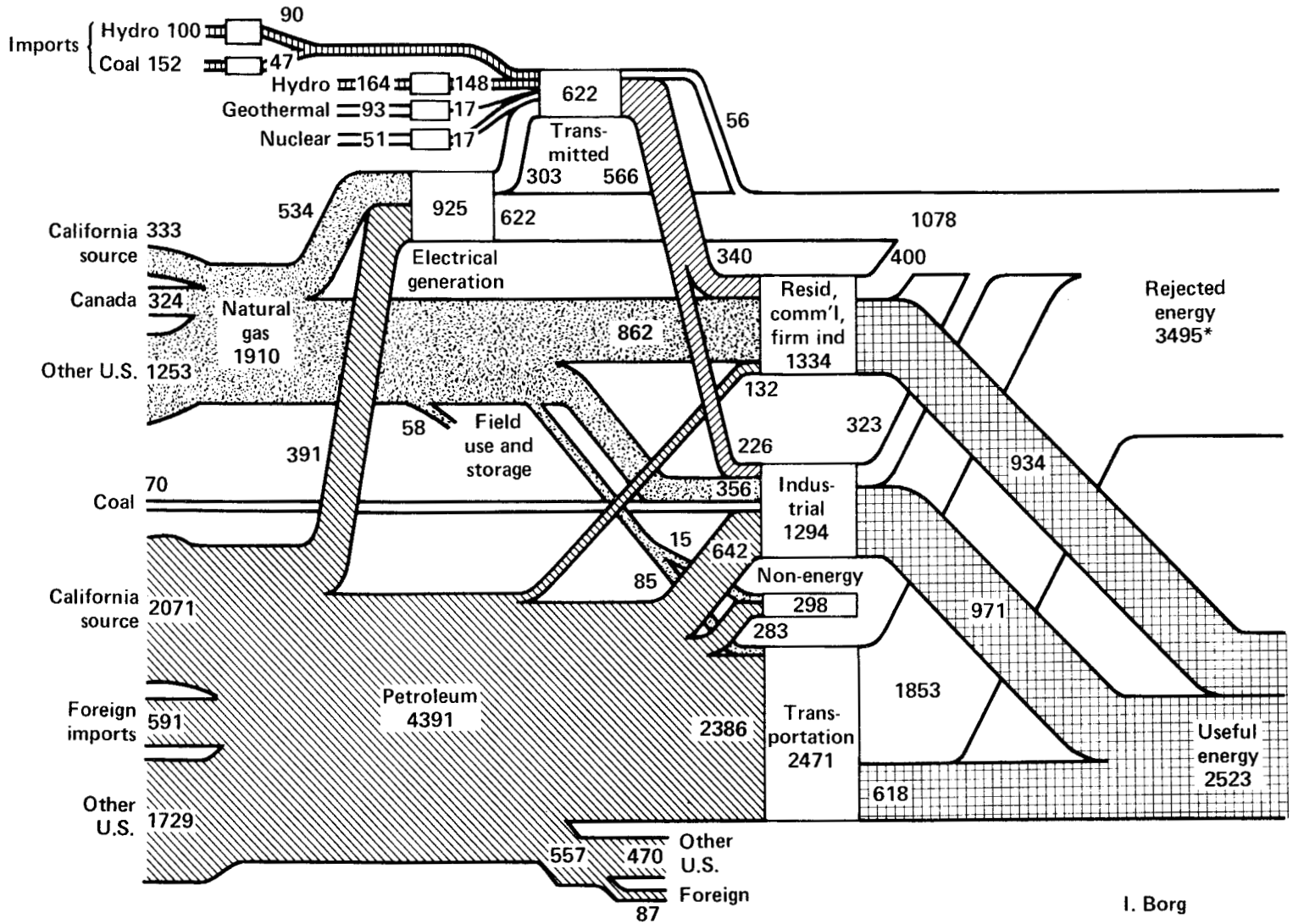
CALIFORNIA ENERGY FLOW – 1981
TOTAL ENERGY CONSUMPTION 6300 X 10^{12}Btu



*Includes rejected energy from hydro, coal, geothermal and nuclear conversions
Data: California Energy Commission; California Division of Oil & Gas, DOE/EIA

Figure 1

CALIFORNIA ENERGY FLOW – 1980
TOTAL ENERGY CONSUMPTION 6400 X 10^{12} Btu



*Includes rejected energy from hydro, coal, geothermal and nuclear conversions

Data: California Energy Commission; California Division of Oil & Gas, DOE/EIA

Figure 2

Table 1

Comparison of Annual Energy Use in California
(in 10^{12} Btu)

	1976	1977	1978	1979	1980	1981	% Change 1980 vs 1981
1980							
Natural Gas	1884	1831	1724	1971	1910	2020	+5
Crude Oil	3886	4516	4379	4587	4391	4180	-5
California Source	1921	2027	2014	2044	2071	2230	+8
Foreign Imports	1606	1875	940	785	591	390	-34
Other U.S.	359	614	1425	1758	1729	1560	-10
Domestic/Foreign Exports	630	796	598	620	557	530	-5
Net Use	3256	3720	3781	3967	3834	3650	-5
Electricity							
Imports*	158	100	121	92	137	180	+31
Imports**	267	208	203	193	252	300	+19
Hydroelectric	94	54	144	134	164	110	-33
Geothermal and Other	79	63	54	71	93	110	+18
Nuclear	51	84	81	96	51	30	-41
Gas	303	380	312	458	534	680	+27
Oil	619	806	619	640	391	280	-28
Total Fuel	1413	1595	1413	1592	1485	1510	+2
Total Transmitted Energy	577	574	597	617	622	620	---
Residential/Commercial/firm industrial	1406	1253	1321	1398	1334	1370	N.V.
Industrial	1162	1248	1088	1216	1294	1400	N.V.
Nonenergy	222	221	239	304	298	165	-45
Transportation	2004	2199	2438	2478	2471	2430	-2

* As imported Mw.h (not energy-fuel equivalents)
** As hydroelectric power or coal before conversion to electricity.
N.V. Not valid (see text)

California oil production set an all time high of 385 million barrels.[7] Increases were largely related to enhanced heavy oil production, initiation of production in the Hondo and Beta Offshore fields for the first year and the continued high production from Elk Hills (Naval Petroleum Reserve No. 1). The latter field reached 179,000 barrels per day in 1981, some 17% of California's total oil production, but began to decline at the end of 1981. Comparable records were not set in indigenous natural gas production (Figure 3) although some increases were recorded.

The mild winter (Table 2) particularly in the southern part of the state freed gas normally dedicated to uninterruptible customers for electric power generation. Increases in imports from the southwest as well as increases in California associated and especially nonassociated gas combined to raise natural gas' share of hydrocarbons used in the state to almost one third. Acquisition costs in current dollars were $2.66 and $3.18 per million Btu in the southern and northern portions of the state respectively.

Use of fuels for transportation remained at 1980 levels (Table 3) but within that broad category of end use several trends were apparent. For one, sales of bunkering fuels remained high which is a reflection of the large share of Alaskan heavy crude oils in California refinery runs. A drop in use of aviation fuel was because of the air controllers' strike that forced curtailment of some flight schedules. Gasoline use appears to have remained at 1980 levels, nonetheless, substantially below 1978-9 levels. The effect of fuel conserving smaller cars in the state's fleet is not easy to discern since population increases estimated at 500,000 and the effects of the recession are also reflected in the data. Two fleets of alcohol-burning automobiles were being tested in the state during 1981.[22] One fleet consisting of nine Ford Pintos (4 run on ethanol and 5 on methanol) was operated by the California Departments of General Services & Transportation; the other fleet run on methanol was under trial by Bank of America. There was, however, no substantive market for either pure alcohol fuels or gasohol in the state.

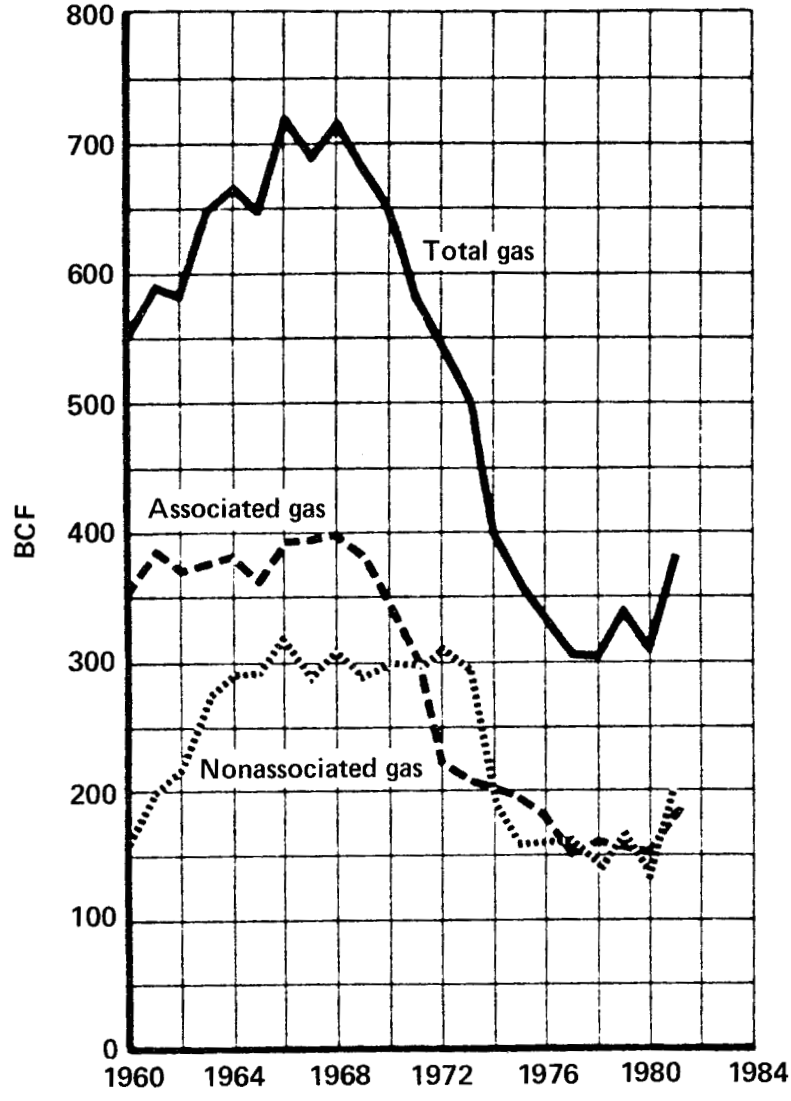


Figure 3

California natural gas production
(outer continental shelf excluded)
(Ref. 7)

Table 2

WEATHER COMPARISON
1958-1981
ANNUAL HEATING DEGREE DAYS*

	San Francisco Federal Office Building	Los Angeles Civic Center	San Diego Lindbergh Field
1958	2332	849	805
1967	2978	1040	1380
1968	2942	850	1052
1969	3066	1032	1145
1970	3006	941	1137
1971	3468	1424	1657
1972	3240	918	1166
1973	3161	1066	1137
1974	3182	1084	1123
1975	3313	1548	1416
1976	2665	1128	793
1977	2888	911	747
1978	2599	1208	736
1979	2545	1160	902
1980	2799	597	590
1981	2819	506	573
Normal 1941-70	3080	1245	1507

*Source Local Climatological Data, for San Francisco, Los Angeles, and San Diego.

National Oceanic and Atmospheric Administration
National Climatic Center
Asheville, N.C.

Table 3

Transportation End Use

	x 10^{12} BTU			
	1978[4]	1979[5]	1980[6]	1981
Net Gasoline	1500	1439	1375	1384
Net Aviation Fuel	357	350	346	335
Taxable diesel fuel-Public Highway	149	161	160	166
Rail diesel	35	35	43	46
Net Bunkering	288	358	430	412
Military	30	30	32	42
Total	2359	2373	2386	2385

Source: 1981 data from Petroleum Supply Annual, 1981, DOE/EIA-0340 (July 1982) and Energy Watch, California Energy Commission (1981) for the net gasoline use.

Natural gas was the largest single source of electrical power in 1981. Next in importance was oil and imports from out-of-state hydroelectric plants and coal-fired generating plants. Nuclear power remained at less than half of 1977-8 levels due to equipment failure at the two licensed plants in the state (Rancho Seco near Sacramento and San Onofre 1 in southern California). In addition, Rancho Seco was refueled in the Spring. By December, however, unit capacity factors* at both had reached 75 to 86%.[23] The Nuclear Regulatory Commission issued a license to the Pacific Gas & Electric Company to load and do low power testing at the Diablo Canyon Nuclear Power plant in November, but it was subsequently revoked when major construction errors in seismic supports were discovered.

Utilities in the state dropped all plans for new coal-fired base load electric generating facilities. The proposed 1600 Mw_e Montezuma project in Solano County was shelved as was the 2090 MW_e Warner Valley-Harry Allen Energy System in Nevada. Reevaluation of projected demand and cost considerations were important in these decisions. Pacific Gas & Electric Co., one of the two utilities involved, found a buyer for its 11,000 acres of Utah coal.[24]

The California Public Utility Commission (CPUC) described the decisions as turning points in utility plans. In the stead of coal-burning facilities, the utilities have made major commitments to purchases of power from small private generating facilities utilizing wind power, small hydroelectric resources, cogeneration and solid waste. At the

*Net power generated x100 divided by the maximum dependable capacity times gross hours.

end of 1981 one utility (PG&E) had signed contracts to purchase 885 MW_e at "avoided cost"*. In 1981, such renewable resources made up about 1% of the utility fuel mix.[24] In addition, the utilities plan to continue development of geothermal resources of the state and bring on stream renewable energy projects of their own such as the 1100 MW_e Helms Pumped Storage Project near Fresno. The CPUC requires utilities in the state to increase their use of alternative energy sources for electrical generation under penalty of having their rate of return reduced if they fail to do so.

Power purchases from out-of-state continue to be a viable option. San Diego Gas and Electric Co. was granted permission to import power from Mexico's Cerro Prieto geothermal facilities in Baja, California, and new transmission lines from Arizona's Palo Verde Nuclear Plant were essentially completed by Southern California Edison Co. Surplus hydroelectric power from the Bonneville Power Administration also appears attractive as a purchase but additional transmission capacity would be required.

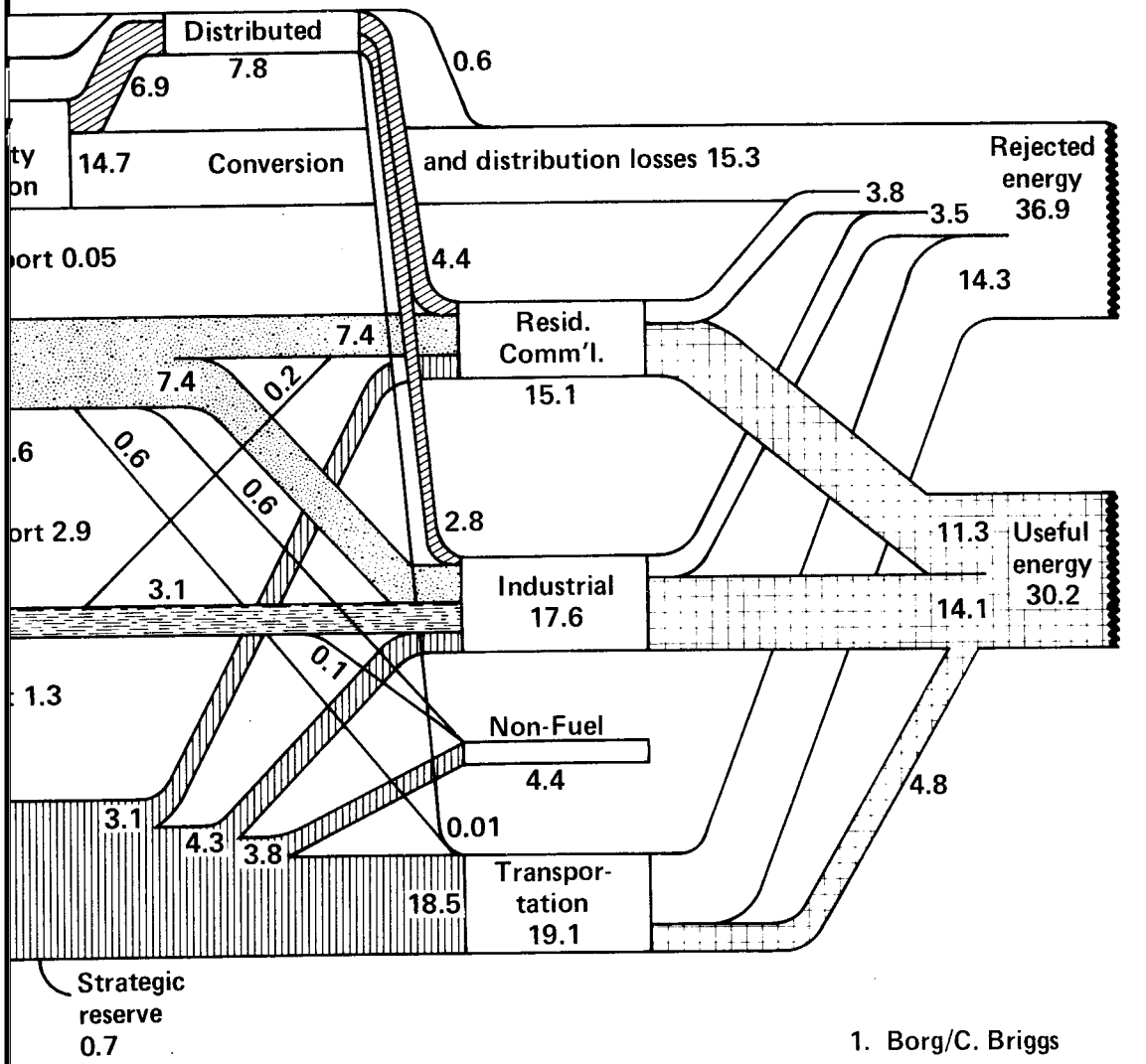
COMPARISON WITH U.S. ENERGY USE

For many years, California's energy mix and consumption patterns have been radically different from those of the rest of the nation. That the situation persists can be verified by comparing Figures 1 and 4, flow charts for California and the U.S. for 1981. The greater importance of crude oil in California reflects on the large petroleum industry in the state that was second only to Texas' for many decades and the consequent historical importance of highway vehicles in the transportation end-use section which persists until today. Coal except for coking in the small California steel industry has never had a role

* What is would cost to produce the same amount of power by burning oil or gas in its own plants—about 7.1¢ per kWH[25].

to play in the California energy picture. Again, because of historical precedent and environmental considerations natural gas has been an important fuel; and in fact, its use has increased since 1977 (Table 1). By contrast in the U.S. gas use has remained constant since 1975 and declined relative to 1970 use. The California pattern has been possible primarily because of increased imports from out-of-state sources since the late seventies. In view of the state's air pollution problems especially in urban areas, it is not surprising that gas has become the preferred fuel for power generation (Table 1). This is in marked contrast to use in the nation as a whole where gas historically has been and is currently much less important than coal for power production.

Other usage patterns in California apart from those in transportation differ from those of the aggregate U.S. because of the basic economic structure of the state. Its agricultural sector unequaled by any other state, and the light manufacturing companies cannot use coal conveniently. Service industries as well as government activities occupy 40% of all non-agricultural workers. (Table 4)


81
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and distribution losses 15.3
Rejected
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ort 0.05
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Resid.
Comm'l.
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ort 2.9
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Useful
energy
30.2
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Industrial
17.6
14.1
0.1
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Non-Fuel
4.4
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0.01
4.3
3.8
18.5
Transpor-
tation
19.1
Strategic
reserve
0.7
1. Borg/C. Briggs

Figure 4

Table 4

Estimated number of workers in non-agricultural establishments in California, 1980[26] (in thousands)

Mining	43
Construction	431
Manufacturing	2001
Transportation & Public Utilities	543
Wholesale trade	582
Retail trade	1685
Finance, insurance, and real estate	621
Services	2165
Government	1767
Total	9838

Appendix A

Data Sources for California Energy Supply (1981)

Production

Crude Oil including Federal Offshore and Leave Condensate	Ref. 7
Associated and Nonassociated Natural	Ref. 7
Electrical Generation (hydro, coal, nuclear, oil, gas, geothermal)	CA. Hydro, Ref. 8, Table 32 Nuclear, Ref. 8, Table 31 Oil & Gas, Ref. 8 Tables 66,67,27,30 Geothermal, Ref. 8, Table 33

Imports

Natural Gas Foreign and Domestic	Ref. 9, Table 2 Ref. 10, p. 6
Crude Oil Foreign and domestic	Ref. 11, Table IV-6
Oil Produces Foreign and Domestic	Ref. 12, Table 3 Ref. 13
Coal	Ref. 14, Table 10
Electrical Power	Coal, Ref. 15 Net Exchange, Ref. 15 and 16

Exports

Oil Products Foreign and Domestic	Ref. 12, (Table 3), and Ref. 13
(not including bunkering fuels supplied at California ports)	

Appendix B

Data Sources for California End Uses (1981)

Net Storage and Field Use	
Natural Gas	Storage Ref. 17 Field Use Ref. 10
Transportation	
Crude Oil	
Consumption of gasoline, aviation fuel and jet fuels	Ref. 18, p. 9 Ref. 12, Table 3
Taxable diesel fuel (i.e. for public highways)	Ref. 19, p. 169
Vessel Bunkering (includes international bunkering)	Ref. 19, p. 169
Exports of gasoline, jet fuel	Ref. 12, Table 3,
Rail diesel	Ref. 19, p. 169
Military Use	Ref. 19, p. 170
Natural Gas	
Lost or unaccounted for from gas utilities (transmission and pipelines)	Ref. 10
Industrial, Government, Agriculture, etc.	
Natural gas	Ref. 17
Coal	Ref. 14, Table 10
Electricity	Ref. 8, Table 126
Crude Oil	by difference
Non Energy Applications	
Crude Oil and LPG	
Asphalt	Ref. 20
Petrochemical feedstock	Ref. 19, p. 149
Waxes, lubricating oils medicinal uses, cleaning	1/3 of asphalt and road oil totals, Ref. 4
Natural Gas	
Fertilizer	Ref. 21
Residential and Small Commercial	
Natural Gas	Ref. 17
Crude Oil and Other Oils (heating) Kerosene, Residual, and Distillate	Ref. 19, p. 162, 164, 165, 166
LPG	Ref. 19, p. 149
Miscellaneous "off highway" diesel	Ref. 19, p. 172
Electricity	Ref. 8, Tables 124, 125

Appendix C: Conversion Units

Energy Source	Conversion factor, 10^6 Btu
Electricity	3.415 per MW.h
Coal	22.6 per short ton
Natural Gas	1.05 per MCF
LPG	4.01 per barrel
Crude Oil	5.80 per barrel
Fuel Oil	
Residual	6.287 per barrel
Distillate, including diesel	5.825 per barrel
Gasoline and Aviation Fuel	5.248 per barrel
Kerosene	5.67 per barrel
Asphalt	6.636 per barrel
Road Oil	6.626 per barrel
Synthetic Rubber and Miscellaneous	
LPG Products	4.01 barrel

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